Piston-Type Accumulator

The invention relates to a piston-type accumulator comprising a separating piston which is axially displaceable within the accumulator housing and which separates two spaces within the accumulator housing from each other, in particular the gas side from the fluid side of the accumulator.

Piston-type accumulators of this type are known in a plurality of designs. The axially guiding part of the accumulator housing which surrounds the separating piston generally has the shape of a cylinder pipe, for which reason piston-type accumulators are often called cylinder accumulators. The seal areas on the piston circumference are conventionally formed by ring seals or O-ring seals which are recessed into outer circumferential grooves which are offset axially to each other in the separating piston.

For use of these cylinder or piston-type accumulators high demands are imposed with respect to their operational reliability, especially over wide temperature ranges, for example between -40°C and +150°C. In a generic piston-type accumulator according to DE 101 39 192 A1, within the accumulator housing at a point located between the seal areas of the separating piston a bleeding possibility has been created for drainage of leaking media passing through the seal areas. As a result of the bleeding possibility between the gas-side and fluid-side seal area in the known solution, it is ensured that media cannot pass from the gas side to the fluid side or vice versa, so that for this purpose a piston-type accumulator is devised which retains its tightness even under extreme conditions and for long periods of use.

The separating piston consisting of a steel material is large in its axial direction of motion within the accumulator housing and can be considered heavy in terms of weight. As a result of the associated sluggish dynamic behavior of the piston-like separating element, the known hydraulic or piston-type accumulator is less suited for applications in which the separating piston must be moved in a rapid sequence, for example in the cases in which on the fluid side high-frequency pressure pulses are delivered into the accumulator, and for those cases in which the piston-type accumulator is supposed to entail less weight, for example in the areas of aeronautics and astronautics.

On the basis of this prior art, the object of the invention is to further improve the known piston-type accumulators while retaining their advantages, such that short trigger times are possible with the separating piston and an accumulator with little weight in use is implemented. This object is achieved by a piston-type accumulator with the features of claim 1 in its entirety.

In that, as specified in the characterizing part of claim 1, the separating piston consists largely or completely of a plastic material, in terms of its weight it can be designed to be very light so that overall the installation weight of the piston-type accumulator is reduced. In this way the piston-type accumulator as claimed in the invention is then especially suited to use in the domains of aeronautics and astronautics and for other applications in which fundamentally weight is to be reduced. Since the separating piston which is made at least partially of plastic material has a low mass compared to the known steel pistons, it can be easily triggered and quickly reversed in the direction of motion so that when high frequency fluid pulsations are being delivered into the accumulator housing, the piston-type accumulator meets the associated requirements, especially with respect to smoothing of the pulsation flow and the like.

In this connection it is provision is preferably made such that at least parts of the interior of the separating piston consist of an injection molding or are obtained by an extrusion process, toward the outside at least partially a reinforcement of plastic fibers or a plastic membrane being applied. In

this way the basic structure of the separating piston can be achieved cost-effectively and the necessary mechanical strength properties for the separating piston can be obtained by the applied fiber or membrane laminate of plastic, even if the separating piston is to be exposed later to high frequency pulsations in its fluid operation.

In one especially preferred embodiment of the piston-type accumulator as claimed in the invention, the separating piston consists of glass fiber-reinforced polyaryl amide. The plastic material used for this purpose has essentially the same coefficient of thermal expansion as the steel used otherwise in the prior art for the separating piston and/or of the steel material for the accumulator housing, especially in the preferred temperature range from -40°C to 120°C, so that in this respect the same structural properties for the separating piston as claimed in the invention are implemented as in the known solutions. In particular, the plastic separating piston has a stable shape so that it is ensured that the seal areas provided on the outer circumference of the separating piston between the separating piston and the inside of the accumulator housing do not change, so that the desired tight accumulator system is implemented to a high degree with the piston-type accumulator solutions as claimed in the invention.

In another preferred embodiment of the piston-type accumulator as claimed in the invention, the separating piston borders a cavity which is open preferably in the direction of the gas side of the accumulator housing. In this way the volume of accumulator gas can be increased by using the cavity so that for this purpose the damping capacity of the piston-type accumulator as claimed in the invention is improved.

In another especially preferred embodiment of the piston-type accumulator as claimed in the invention, within the cavity there are stiffening crosspieces which, configured diametrically to the longitudinal axis of the accumulator housing, extend from this longitudinal axis to the cylindrical inside wall of the separating piston which laterally borders the cavity. In one modified embodiment

provision can preferably be made such that the ends of the stiffening crosspieces facing away from the inside wall end in a cylindrical hollow receiving ring within the separating piston. Due to the stiffening crosspieces which extend radially from the center of the separating piston to the outside, the indicated sealing area is stiffened toward the inside wall of the accumulator housing relative to the separating piston and the sealing elements provided on the outer circumference of the separating piston and optionally guide strips are kept in contact with the inside of the accumulator housing.

The piston-type accumulator as claimed in the invention will be detailed below using different exemplary embodiments as shown in the drawings. The figures are schematic and not to scale.

FIG. 1 shows a longitudinal section through the piston-type accumulator as claimed in the invention with a separating piston axially displaceable within the accumulator housing;

FIGS. 2a and 2b show in a top view and in a longitudinal section along line II-II from FIG. 2a the separating piston shown in FIG. 1;

FIGS. 3a and 3b show in a top view and in a longitudinal section along line III-III from FIG. 3a a modified embodiment of a separating piston which can replace the separating piston shown in FIG. 1.

The piston-type accumulator shown in FIG. 1 has an accumulator housing designated as a whole as 10 with a cylindrical jacket 12 (cylinder pipe) which is sealed on the end side by two cover parts 14, 16. The cover part 14 which is the left one viewed in the direction of looking at FIG. 1 has a fluid connection 18 which makes it possible to connect the separating piston to the piping of the hydraulic system which is not detailed, to carry fluid, in order in this way to connect the hydraulic

system to the fluid side 20 of the separating piston. The cover part 16 which is the right one viewed in the direction of looking at FIG. 1 within the cylindrical jacket 12 encloses a gas space 22 which can be filled for example with nitrogen gas.

To refill the gas space 22 which is also called the gas side of the separating piston, a replenishing valve (not shown) located in the cover part 16 can be used. To separate the fluid side 20 from the gas side 22, within the accumulator housing 10 with its cylindrical jacket 12 there is a separating piston 24 which is axially displaceable back and forth depending on the system state of the separating piston along its longitudinal axis 26. This structure of a separating piston is prior art so that it will not be detailed here.

In contrast to the known solutions in which the separating piston consists of a steel material, the solution as claimed in the invention consists largely or preferably completely of a plastic material with reference to the separating piston 24. The separating piston 24 overall can be formed from a plastic injection molding, and built up in multiple layers can be obtained using a conventional extrusion process; especially good strength values for the separating piston 24 have however resulted, if it is built up in this way on its inside and to the outside a reinforcement of plastic fibers or a plastic membrane is applied in the form of a laminate. It has proven especially advantageous to build the separating piston 24 from glass-fiber reinforced polyaryl amide, since with this structure the separating piston 24 has essentially the same coefficient of thermal expansion as the steel material from which the cylindrical jacket 12 of the accumulator housing 10 is formed, in addition to the indicated cover parts 14, 16. In the preferred operating or temperature range of the accumulator from approximately 40°C to 120°C or higher, the separating piston 24 thus behaves like the steel material surrounding it with the result that seal problems due to possible temperature fluctuations in the material with different coefficients of thermal expansion are avoided.

As the figures furthermore show, the separating piston 24 borders a cavity 28 which is open in the direction of the gas side 22 of the separating piston 10. In this way, the accumulator capacity for the working gas within the piston-type accumulator can be increased and accordingly its ability to damp fluid shocks delivered on the fluid or fluid side 20 of the piston-type accumulator. Furthermore the formation of the cavity 28 reduces the weight of the moving separating piston 24; this also benefits the reduction of mass inertia so that the separating piston 24 as claimed in the invention can be triggered very rapidly into its dynamic behavior and especially its direction of motion in the accumulator housing 10 can be immediately reversed depending on the operating state.

Within the cavity 26 there are stiffening crosspieces 30 which, running diametrically to the longitudinal axis 26 of the accumulator housing 10, extend from the axis to the cylindrical inside wall 32 of the separating piston 24, which wall laterally borders the cavity 28 for this purpose. As a result of this stiffening by way of the stiffening crosspieces 30, the separating piston 24 can be made very light in terms of its weight and is still designed to have high strength for forthcoming processing tasks, to which the aforementioned glass fiber reinforcement also contributes. For the two embodiments shown in FIGS. 2 and 3 there are a total of six stiffening crosspieces 30 which can also be accordingly increased or decreased in number depending on the forces which occur. In the embodiment shown in FIGS. 1 and 2, the ends of the stiffening crosspieces 30 which face away from the inside wall 32 discharge into a cylindrical receiving ring 34 within the separating piston 24; this leads to an increase in the stiffness of the overall system, since the free path length of the stiffening crosspieces 30 on which they could collapse under load is reduced accordingly. For purposes of a lightweight construction in turn the receiving ring 34 has a middle cylindrical recess 36 which runs coaxially to the longitudinal axis 26 of the accumulator housing 10 and of the separating piston 24. The stiffening crosspieces 30 are made rectangular in cross section and extend over the entire height of the cavity 28 so that the outer ring 38 of the separating piston 24 is stiffened over its entire axial travel length, to which the bottom part 40 also contributes, on which viewed in

the axial travel direction both the stiffening crosspieces 30 and also the receiving ring 34 are supported on the end side.

Furthermore, the separating piston 24 along its outer ring 38 has groove-like recesses 42, 44, and 46, the recesses 42 and 44 being used to hold seals 48, especially formed from a gasket, consisting of elastomer material. The interposed recess 46 can be used to hold a guide strip which is not detailed in order in this way to facilitate the longitudinal traveling motion of the separating piston 24 on the inner circumferential side of the cylindrical jacket 12. The guide can also be molded on as a ring, in a special production process different material can also be molded together in the mold. In this way special material with special sliding properties can be used for the guide.

The modified embodiment shown in FIGS. 3a, 3b corresponds for the most part to the embodiment as shown in FIGS. 1 and 2, only instead of the receiving ring 34 with a central middle recess 36, there being a linkage point 50 for the stiffening crosspieces 30 extending from there in a star shape.